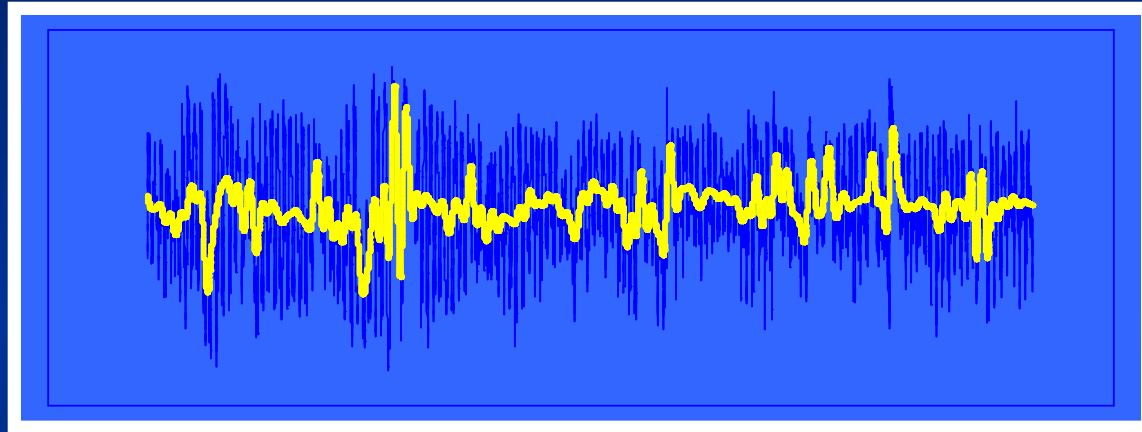


Hydroacoustics and the USGS



D. Phil Turnipseed, P.E.
Joint USACE-USGS
Meeting

USGS National Center
Reston, Virginia
November 29, 2006



U.S. Department of the Interior
U.S. Geological Survey

Issues

- **Increasing coastal population**
- **Freshwater outflows to the Atlantic, the Pacific and the Gulf of Mexico**
- **Operation and maintenance of dams and floodways**
- **Coastal Restoration**

Historical roadblock

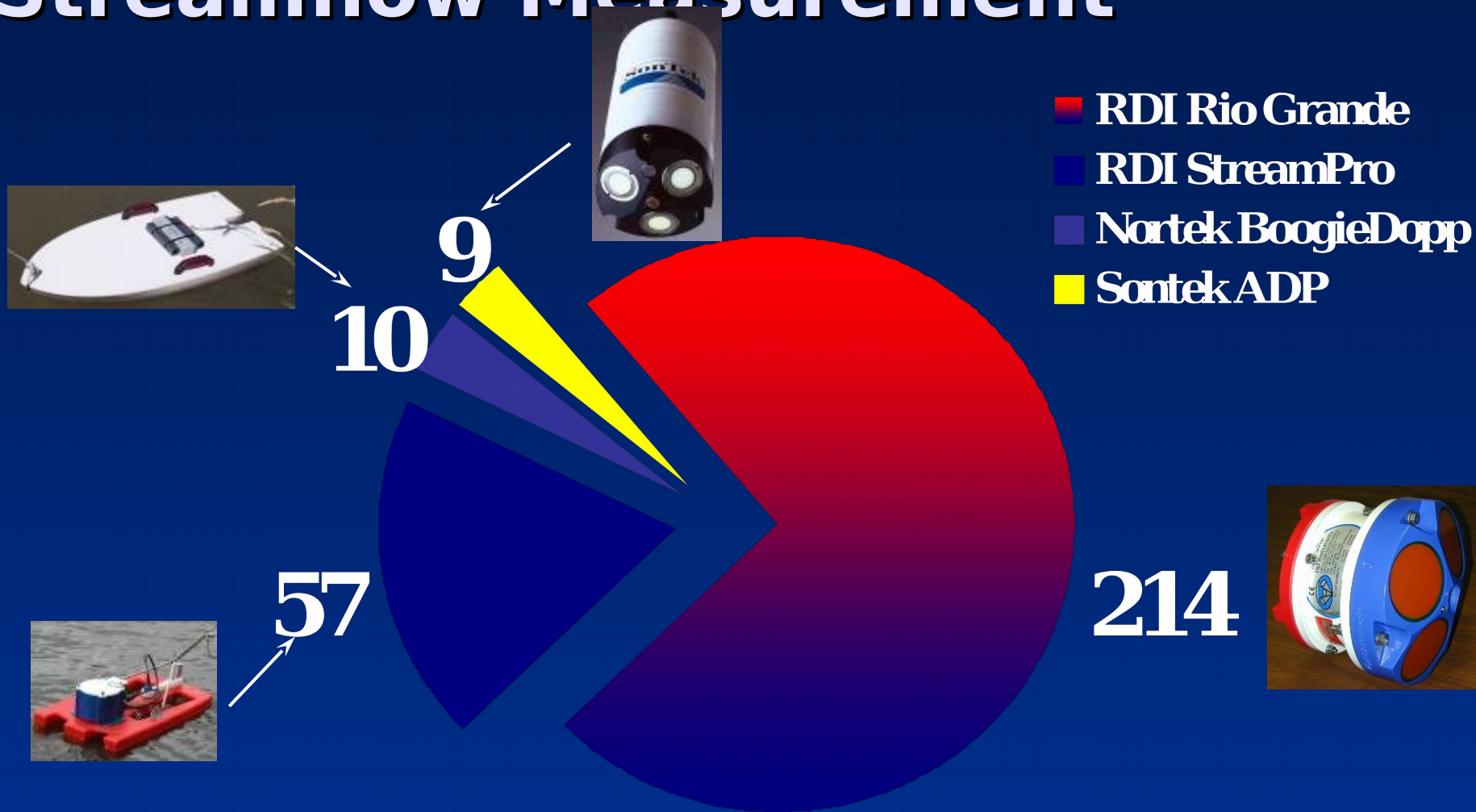
**Unsteady (varied, non-uniform)
open channel flow**

Agenda

- **Acoustic Doppler Current Profilers (ADCPs) and the USGS**
- **Index Velocity**
- **New developments in hydroacoustics**
- **Quality Assurance**

Acoustic Doppler Current Profilers (ADCPs)

ADCPs Used in the USGS for Streamflow Measurement



Updated July
2006

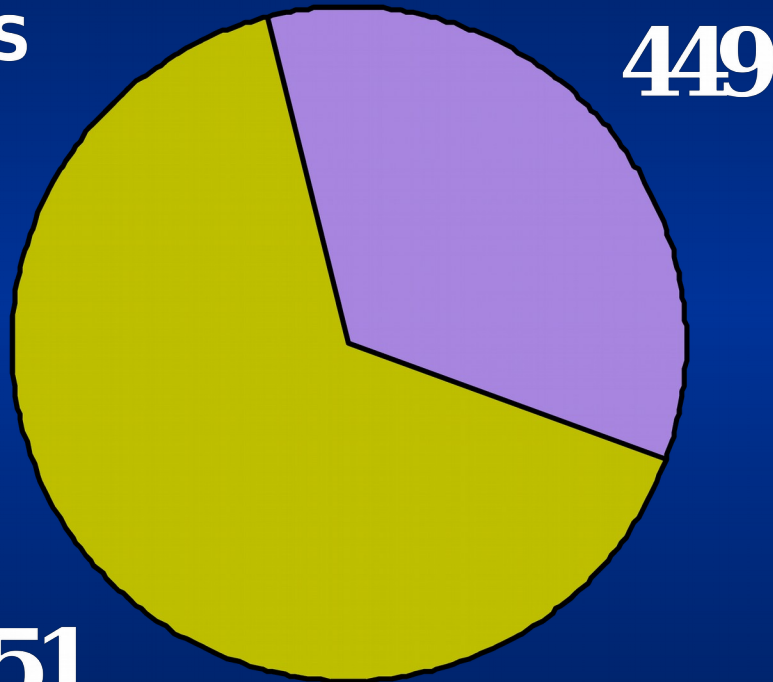


11.9% (3,522) of discharge measurements
from Oct 1, 2005 to April 15, 2006

FlowTracker Use

■ Other Agencies

■ USGS

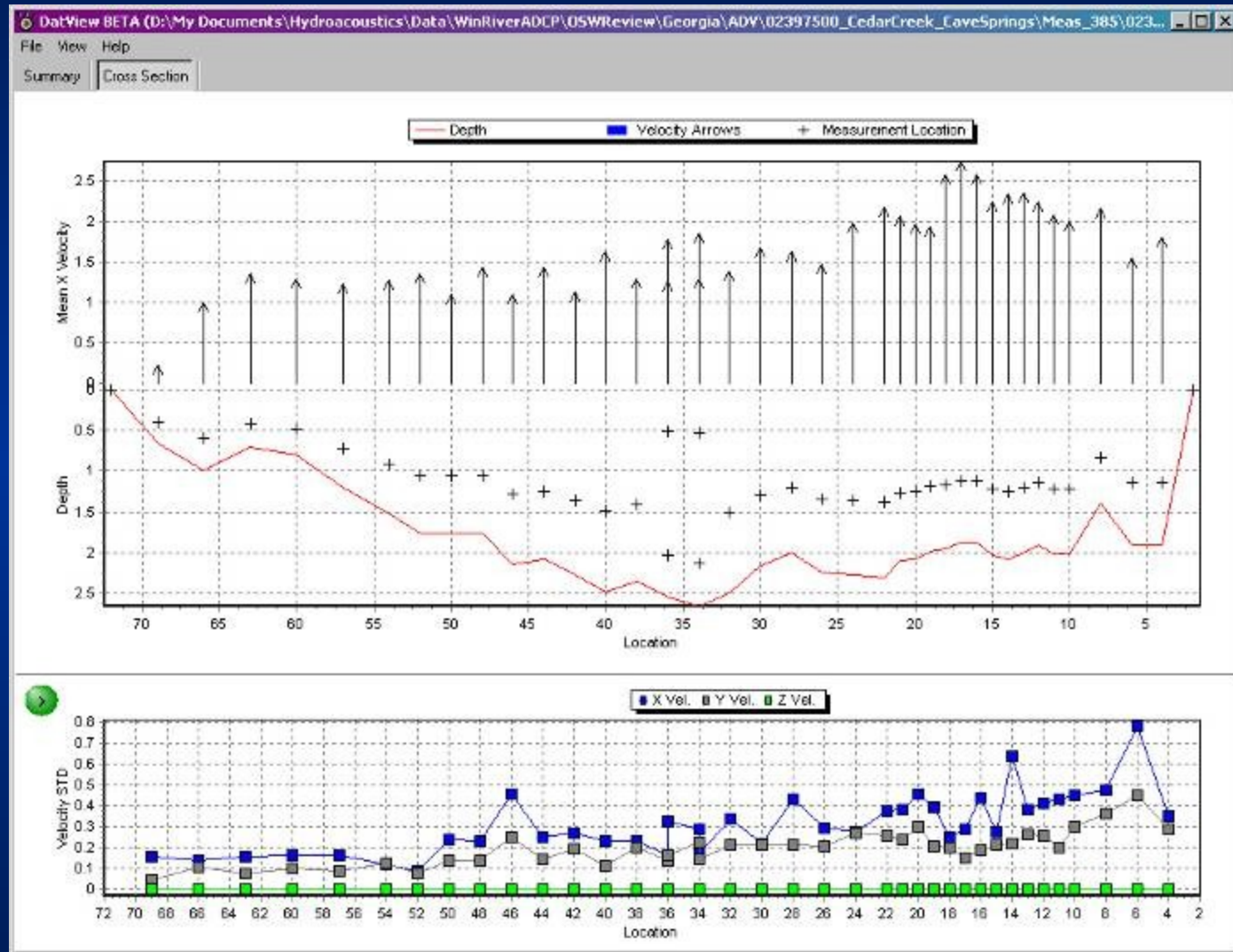


851

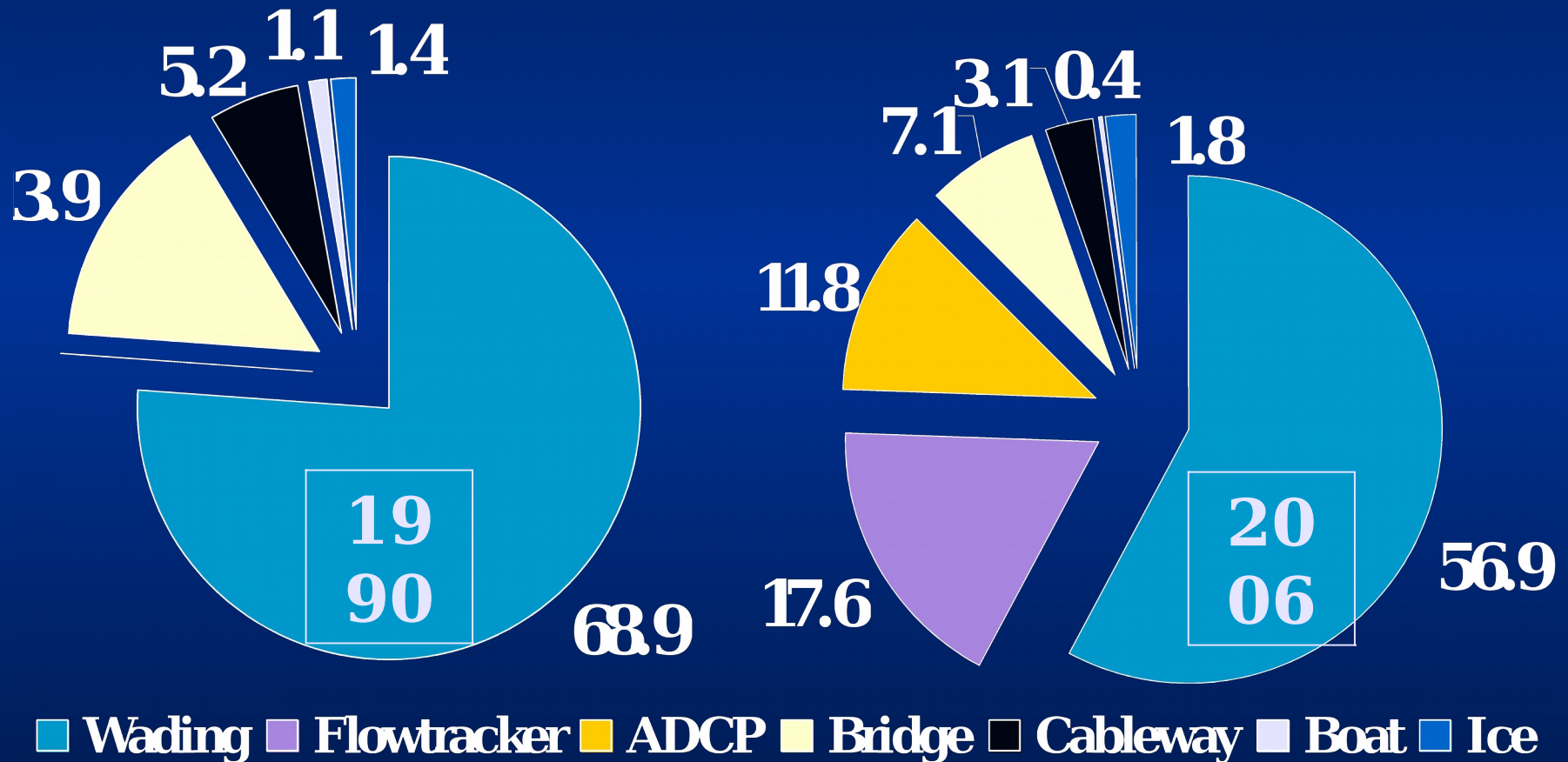
449

17.6% (5,244) of discharge measurements
from Oct 1, 2005 to April 15, 2006

FlowTracker Data Review



29% of USGS Qm's made with Hydroacoustic Instruments in 2006!



Flood Measurements Using ADCPs

- **January 1991 flood**
(Current Meters)
 - 52 Discharge Measurements in 10 days
 - Average Qm time -- 96 minutes
 - 11 hydrographers
- **July 2003 flood** (ADCPs)
 - 62 Discharge Measurements in 10 days
 - Average Qm time -- 18 minutes
 - 6 hydrographers

Index Velocity

Conventional Stage-Discharge Rating Empirical Relationship:

$$GH = Q$$

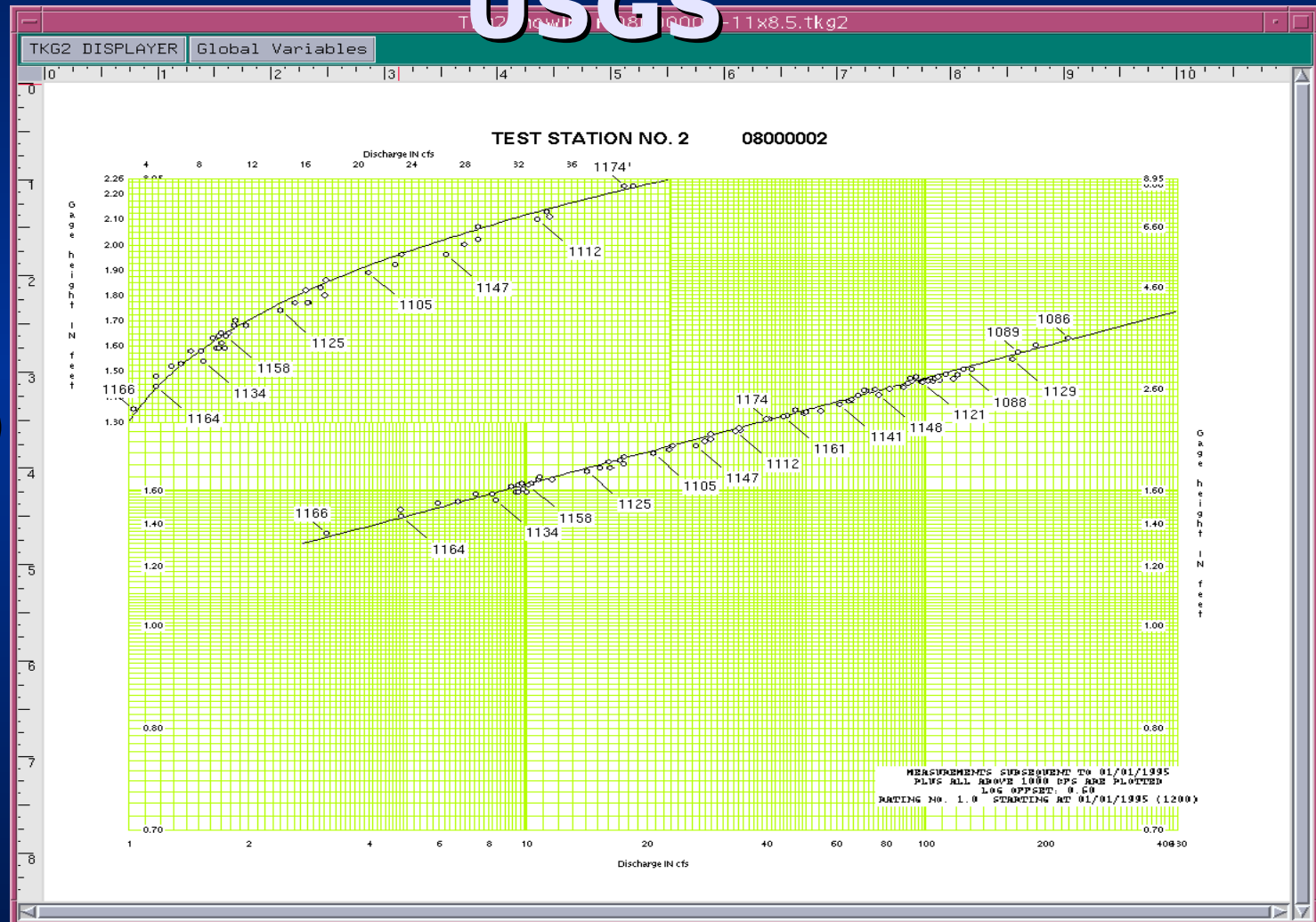
Where for a given channel cross-section:

Q = discharge in ft³/s;

GH = river stage in ft;

Conventional Stage-Discharge Ratings of the USGS

Stage (feet)



Discharge (cubic feet per second)

Continuity Equation:

$$Q = VA$$

Where for a given channel cross-section:

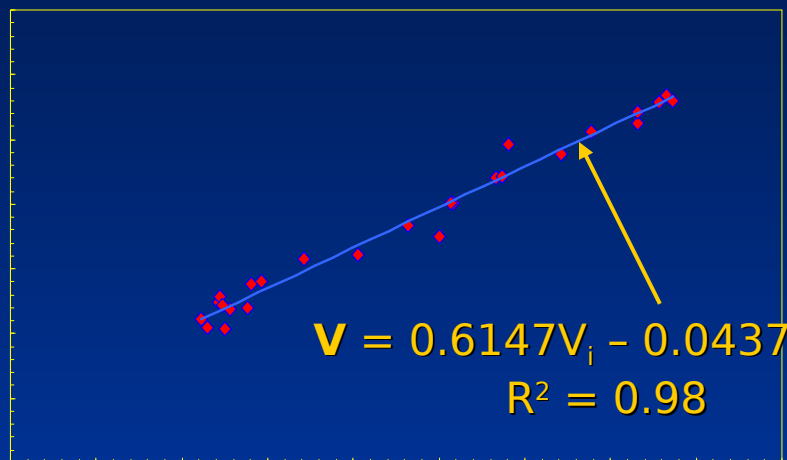
Q = discharge in ft³/s;

V = the **average velocity in ft/s;**

A = cross sectional area in ft²

Average velocity (V) / ADVM velocity relation

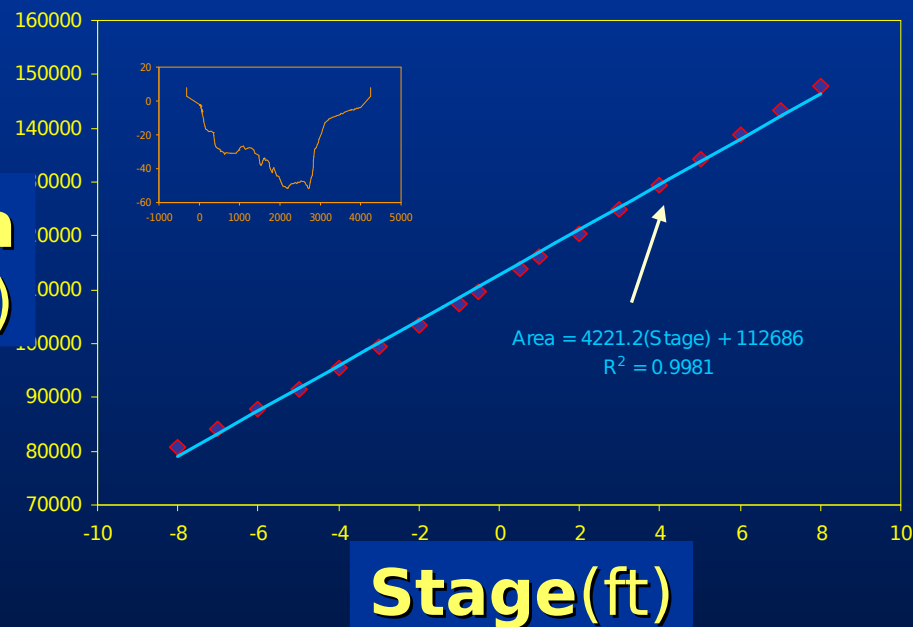
V
(ft/s)



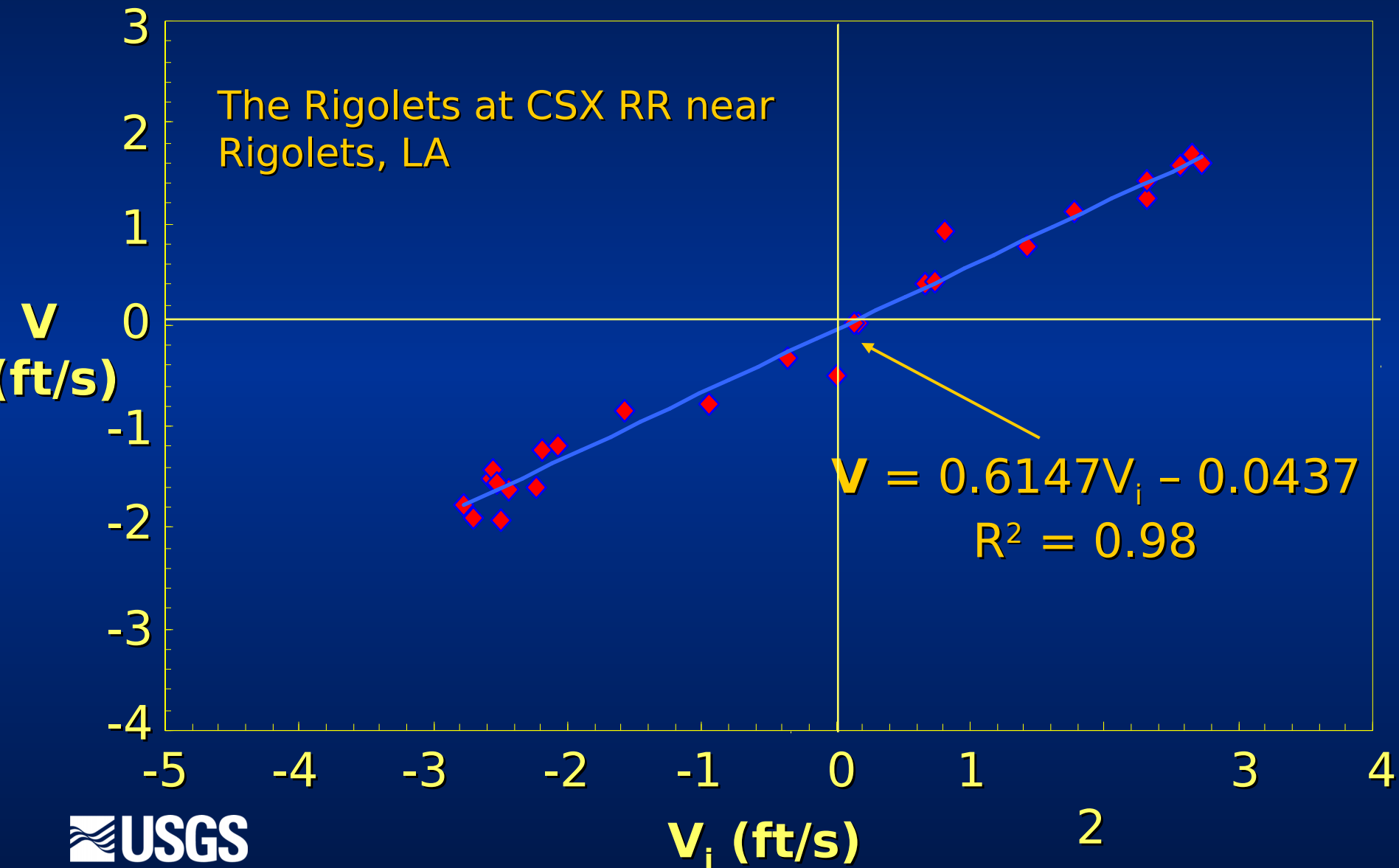
V_i (ft/s)

Cross-sectional area (A) computation

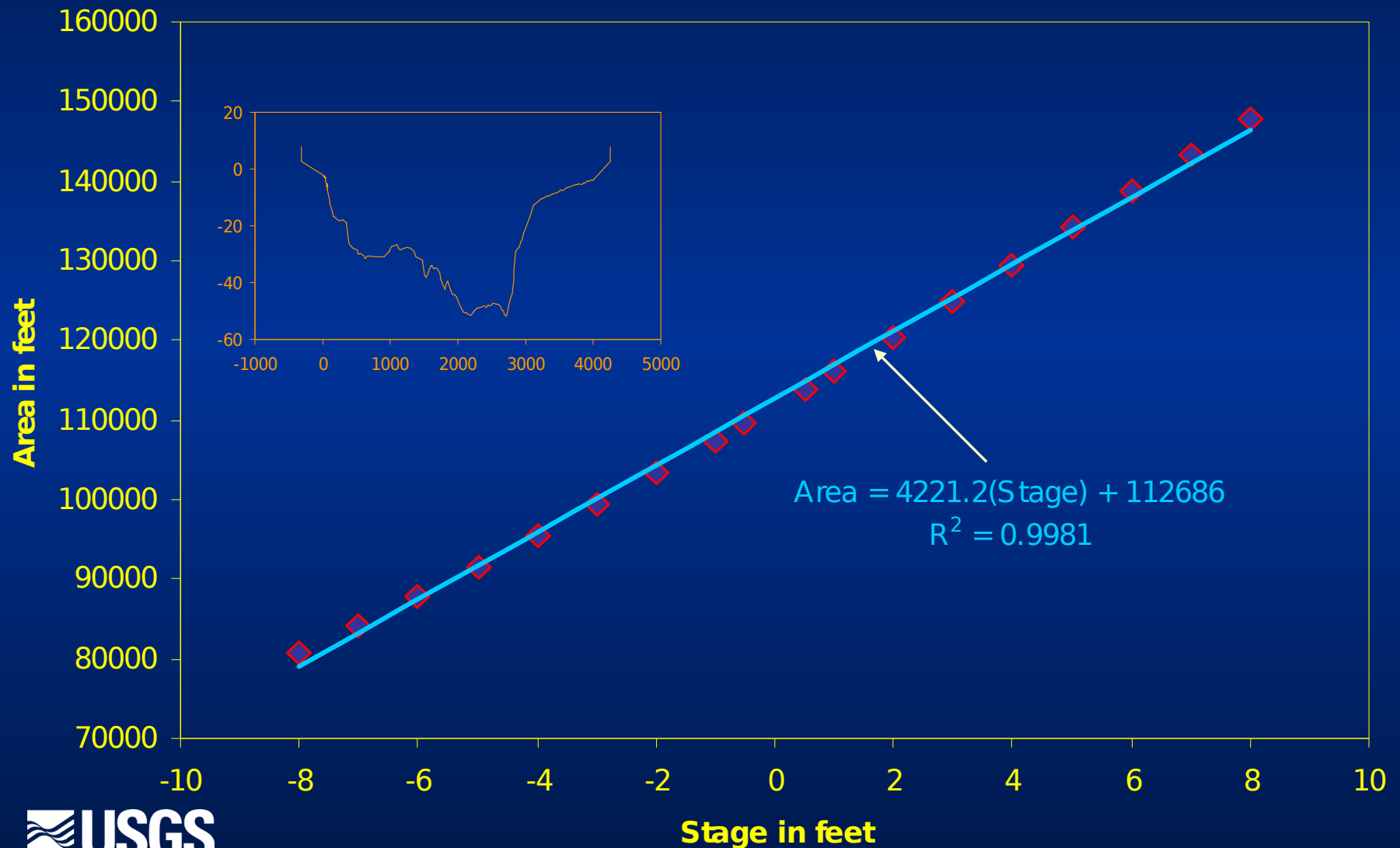
Area
(sq.ft.)



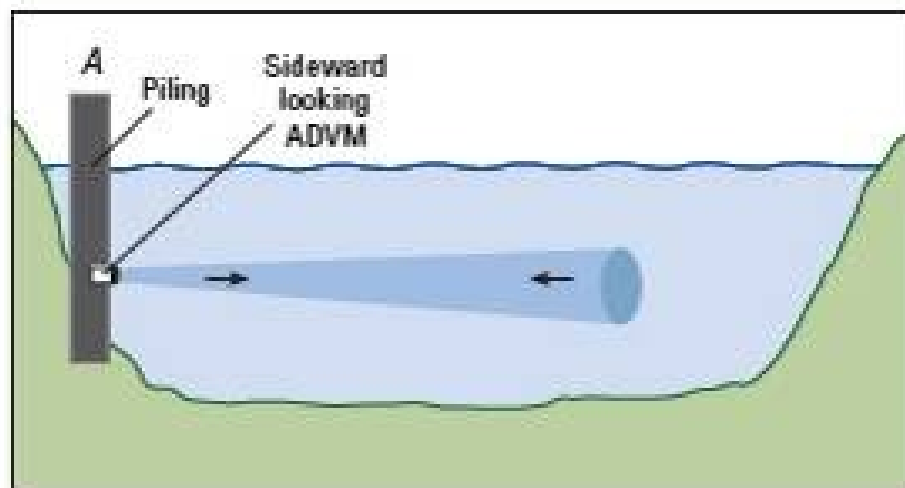
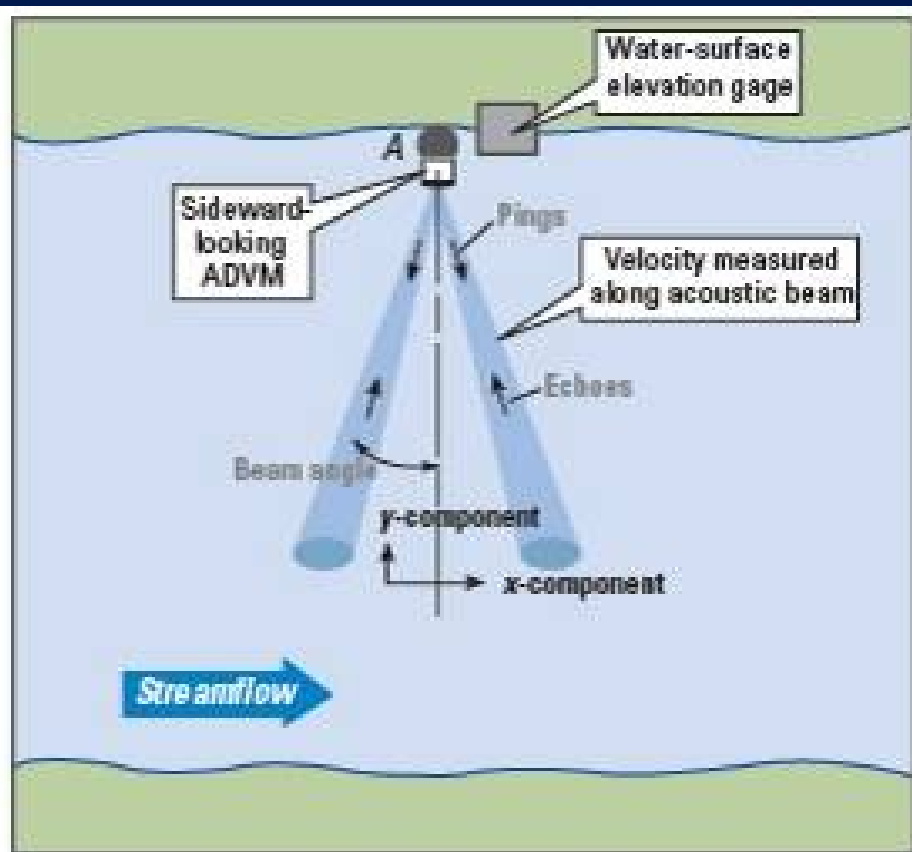
Average velocity (V) / ADVM velocity relation



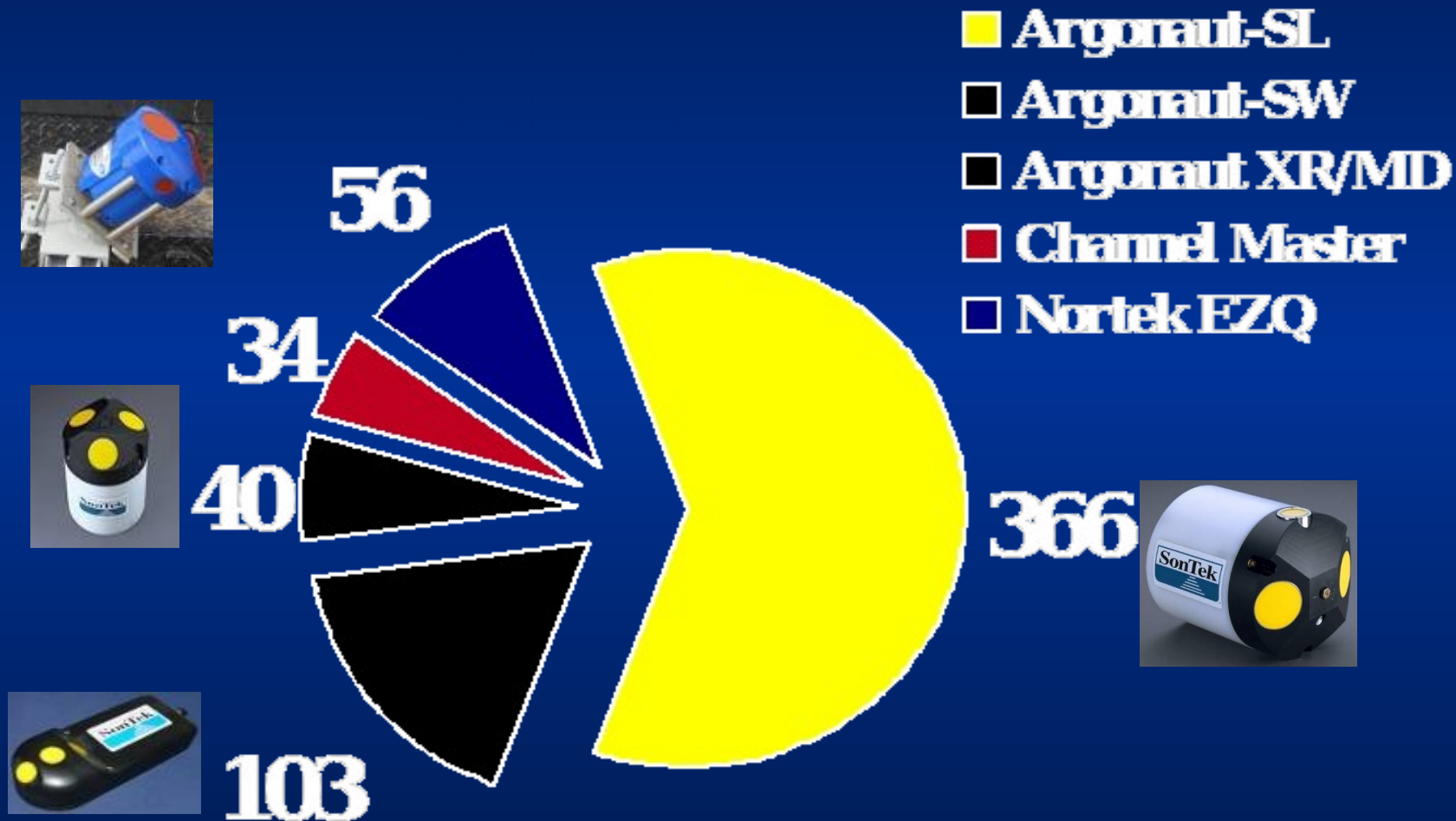
Cross-sectional area (A) computation



Index Velocity Meters

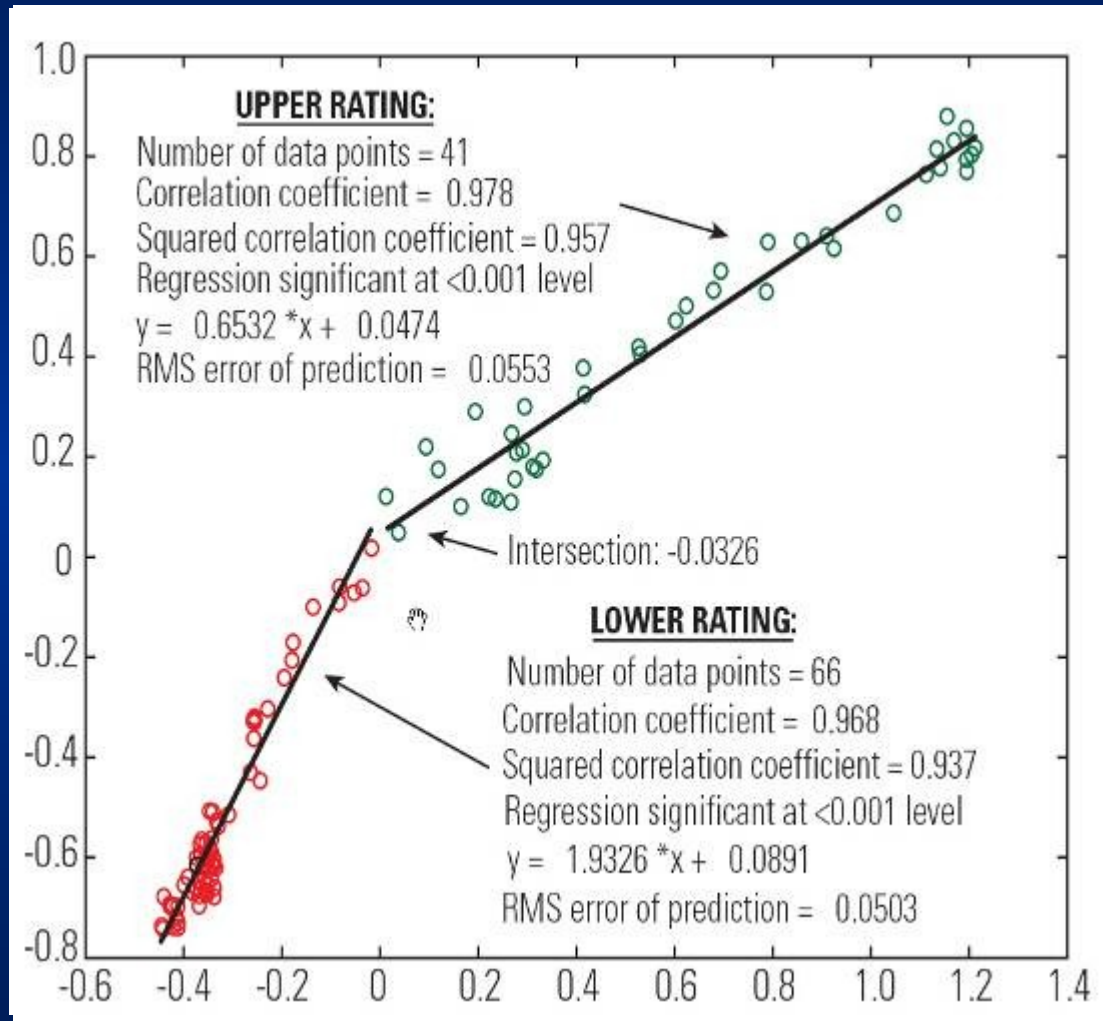


Index-Velocity Instruments

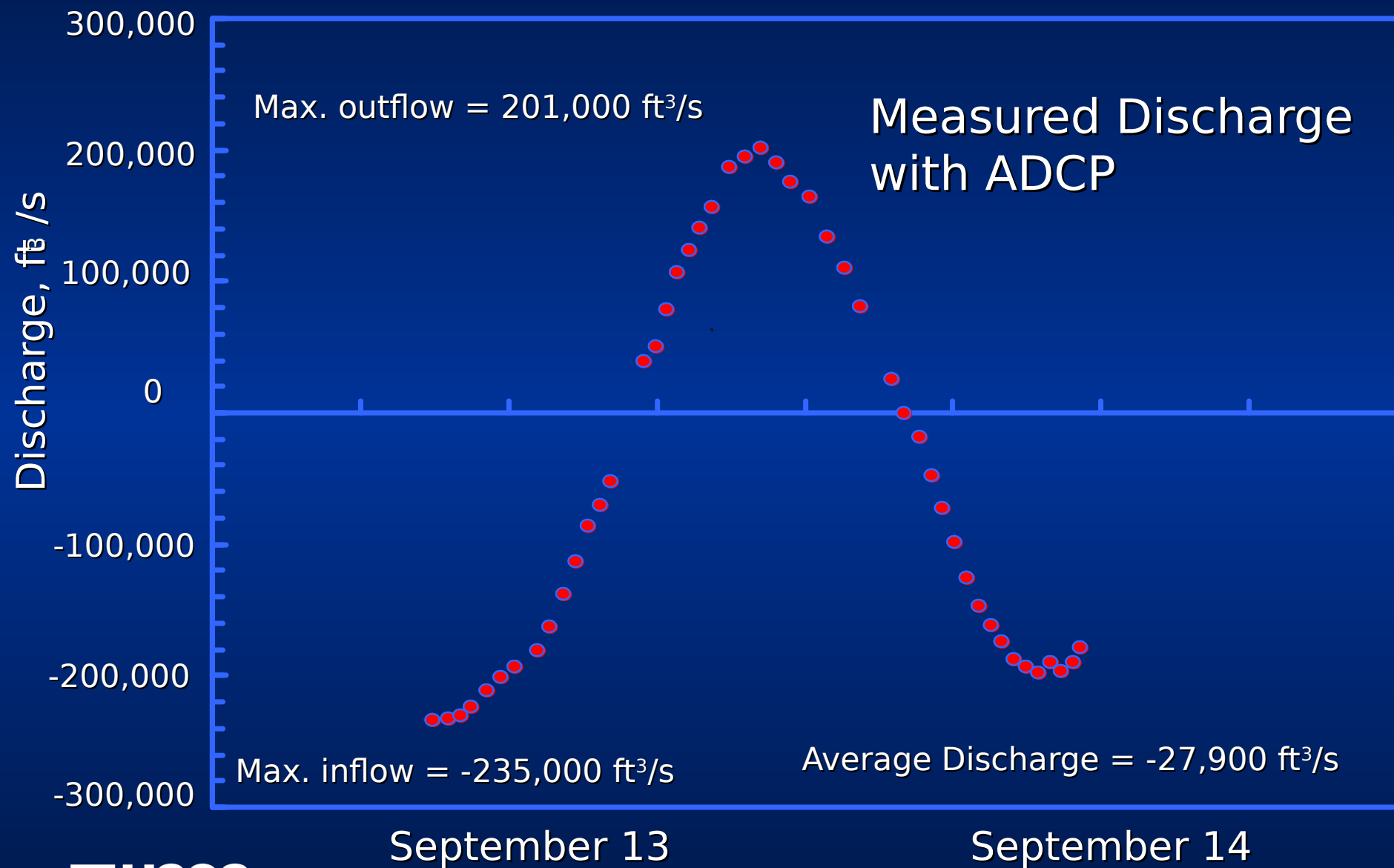


Index Velocity Ratings

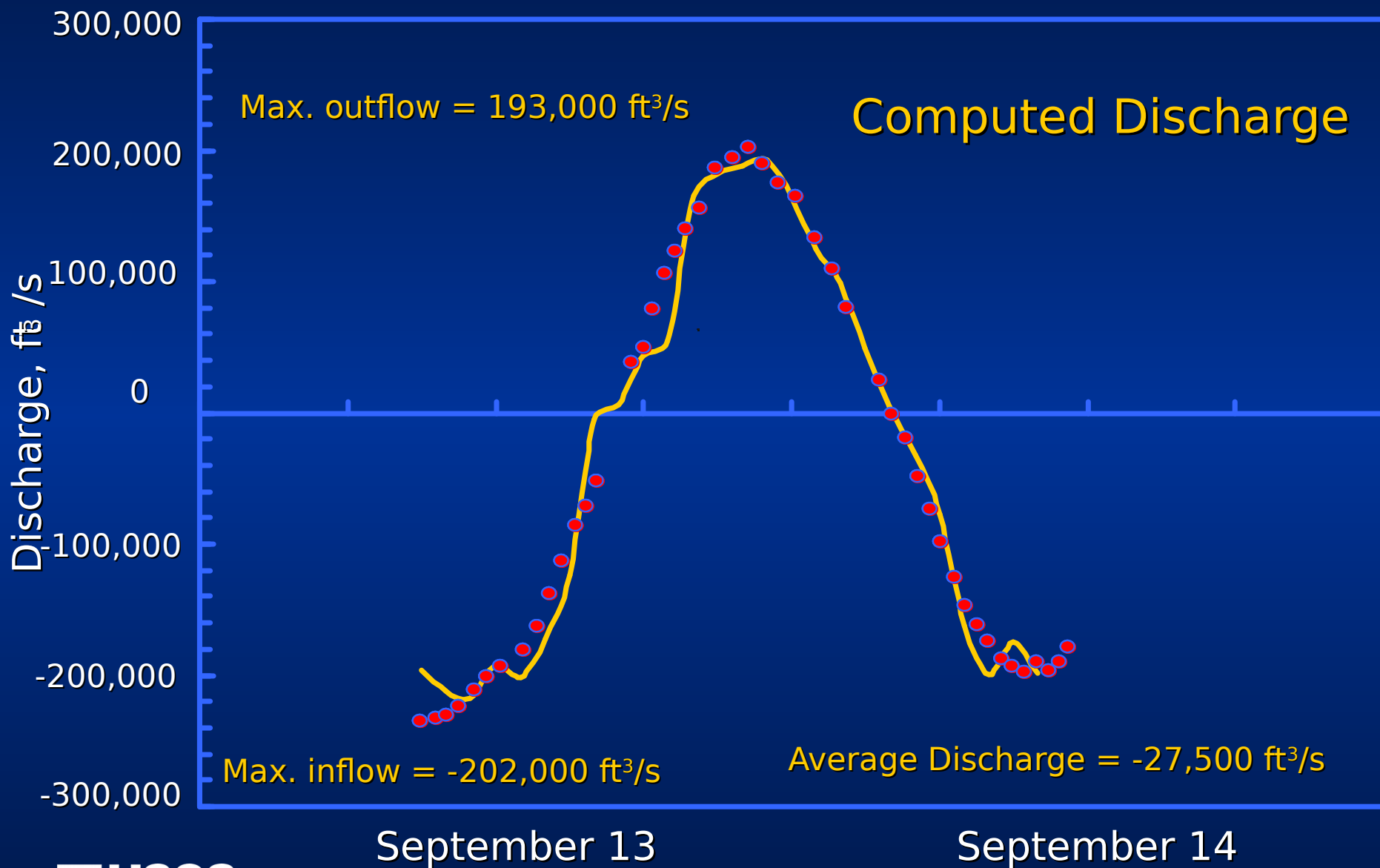
Ave. Velocity
(ft/s) from Qm



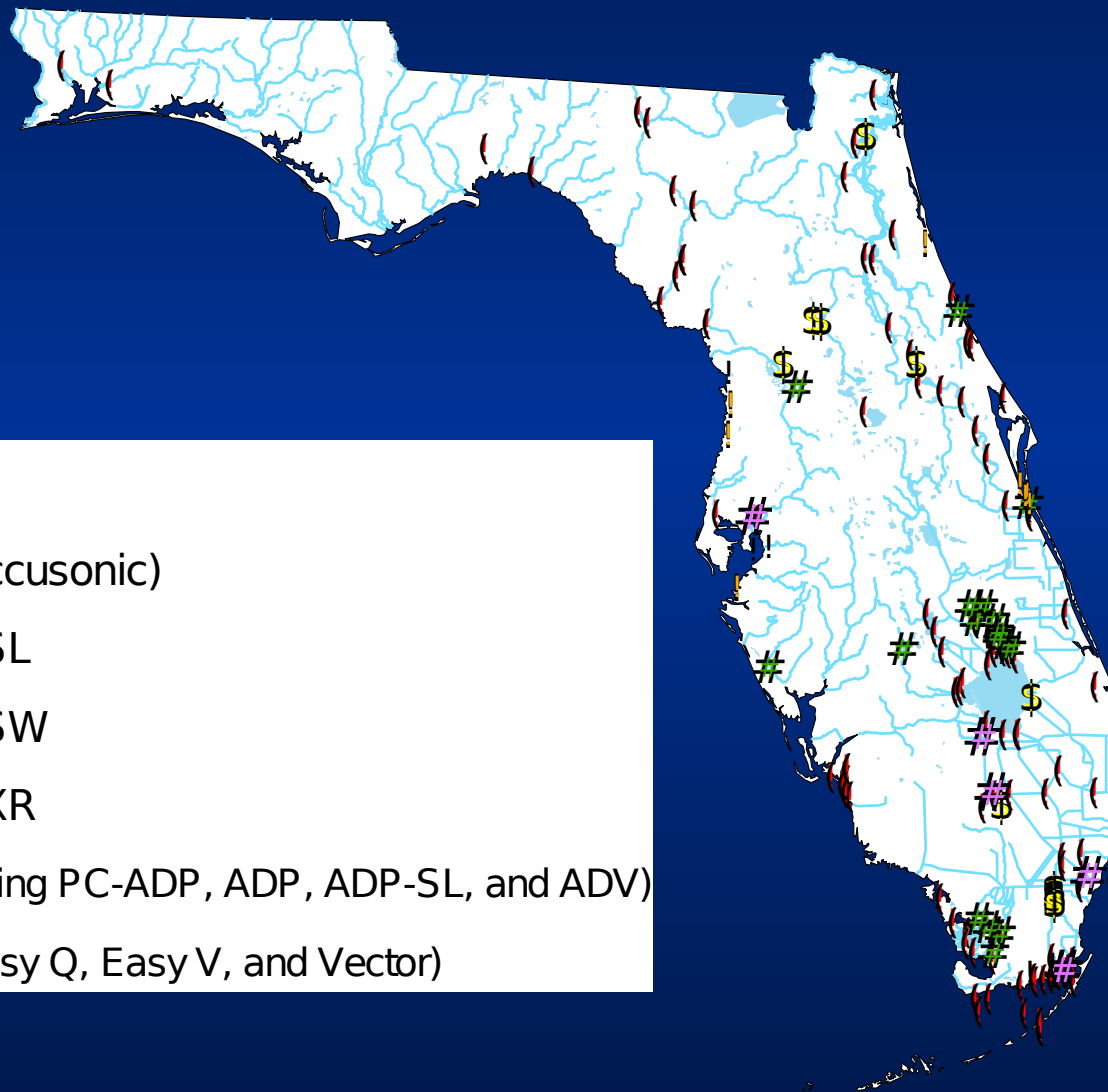
The Rigolets at CSX RR near Rigolets, LA



The Rigolets at CSX RR near Rigolets, LA



Florida In-situ Hydroacoustic Deployments



Legend

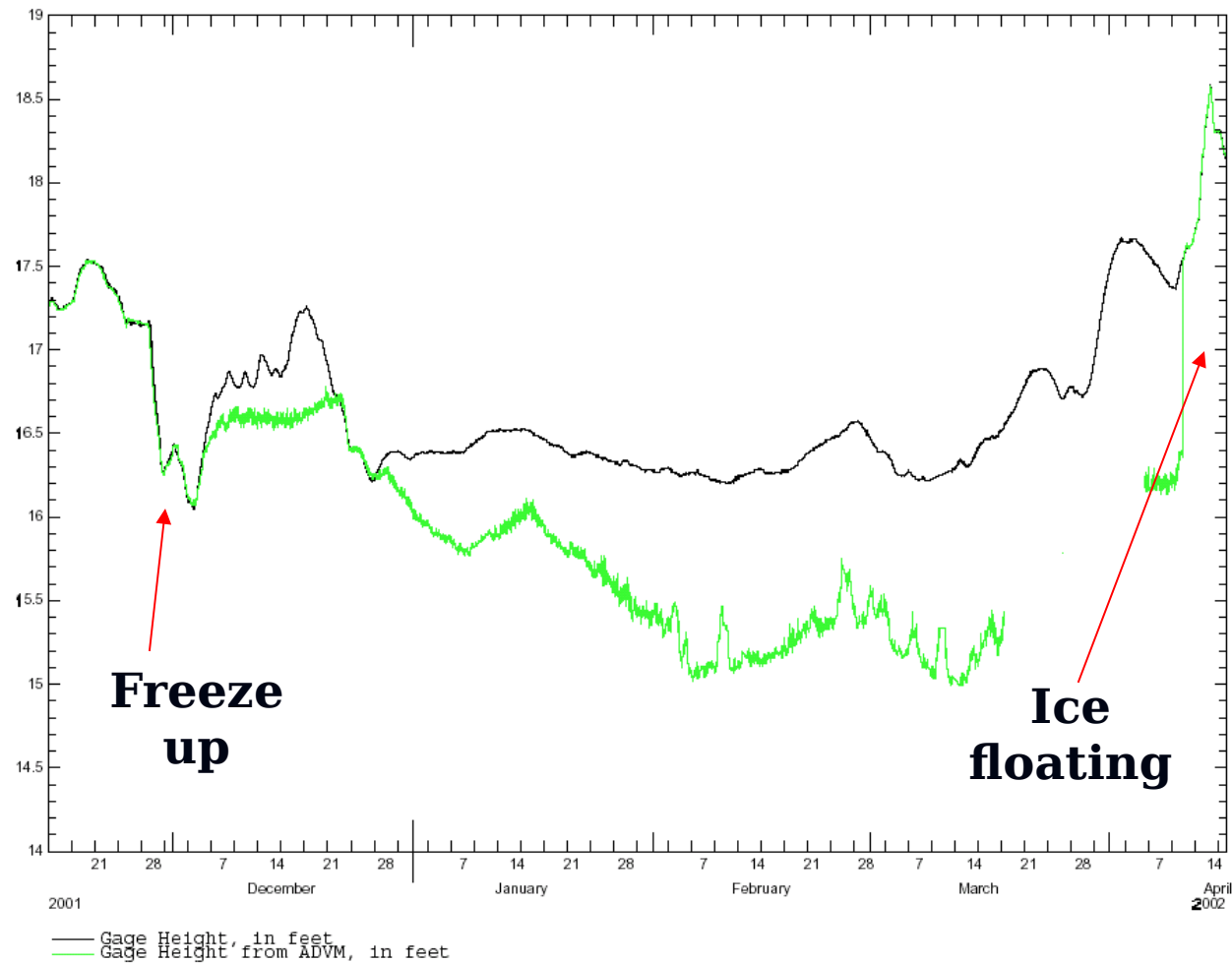
- \$ AVM (Affra and Accusonic)
- (Sontek Argonaut SL
- # Sontek Argonaut SW
- ! Sontek Argonaut XR
- ! other Sontek (including PC-ADP, ADP, ADP-SL, and ADV)
- # Nortek (including Easy Q, Easy V, and Vector)

Measurement of Flow under Ice



Pressure Transducer Stage and Acoustic Stage Measurement

Gage Height
(ft)



Summary of Hydroacoustic Instruments



290

- River Profilers
- Index Velocity
- FlowTrackers



449



610

New developments in hydroacoustics

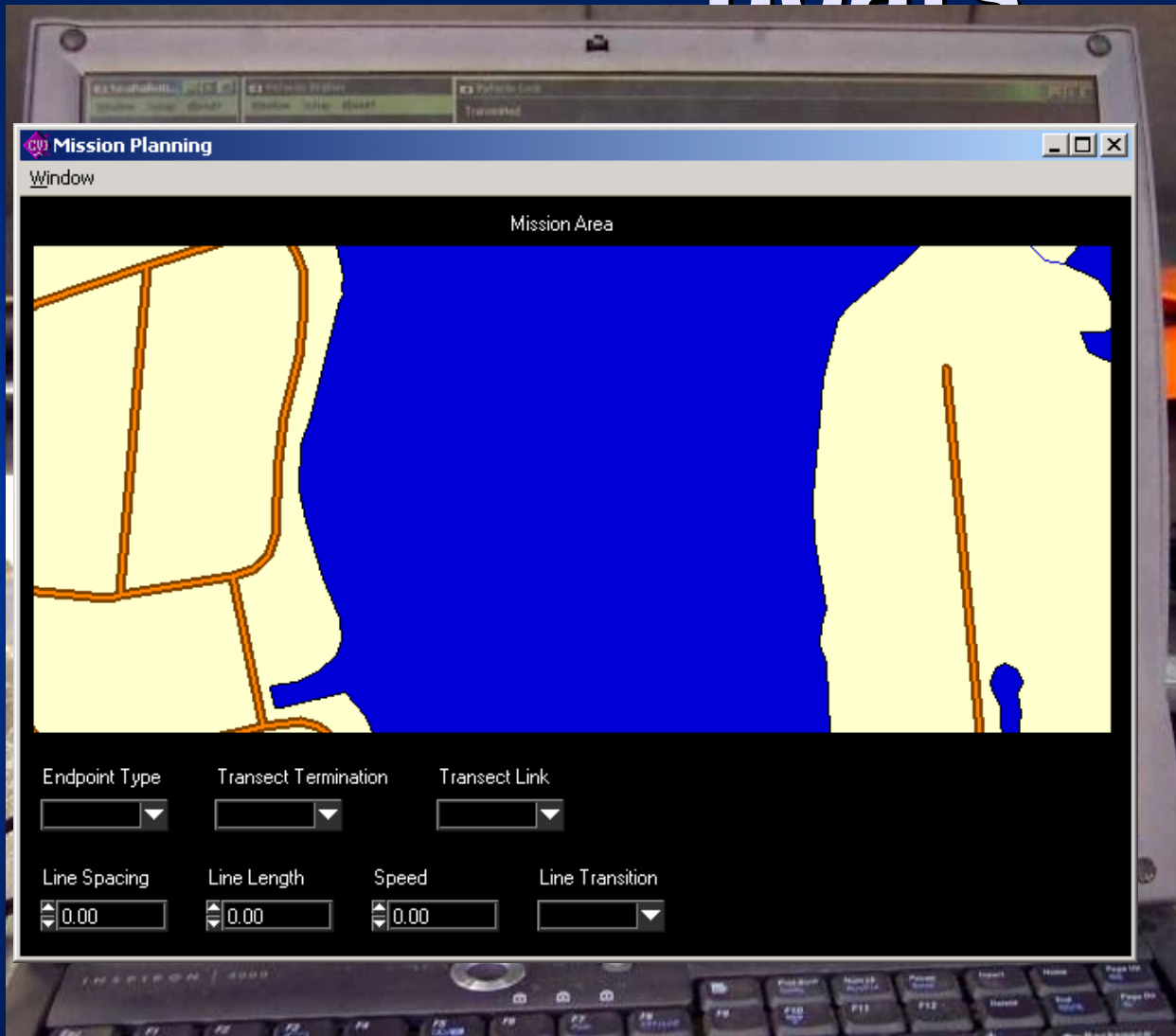
OceanScience High-Speed Boat



RC Boat - SeaRobotics



Semi-Autonomous Controlled Boats



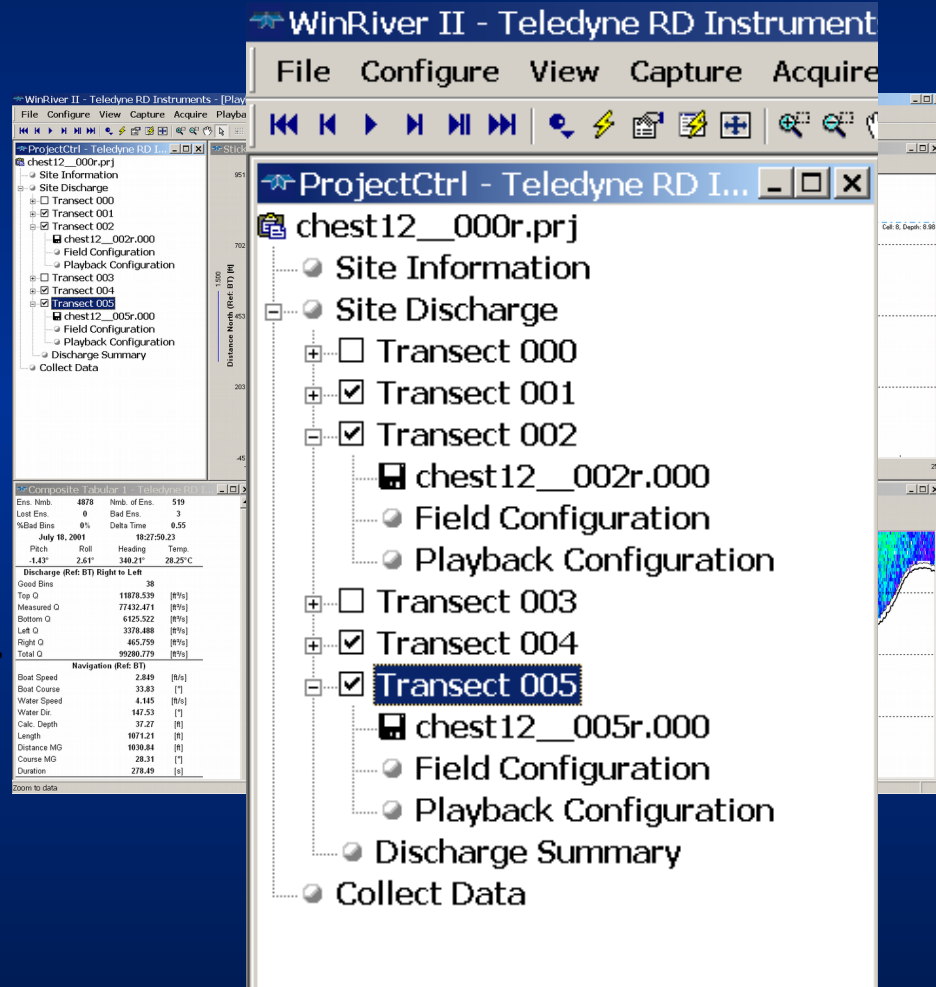
Next Generation ADCP

- Integrated system
 - ✓ Compact 600kHz Phased Array Transducer
 - ✓ New compact, low power electronics set
 - ✓ Bluetooth wireless comms
 - ✓ More automated, wizard-based software
 - ✓ Trimaran float, 10-18 VDC
 - ✓ External options: DGPS, depth sounder



WinRiver II

- New user interface - Site-centric design
- Improved configuration wizard supplied by USGS
- Automated data analysis supplied by USGS
- Improved handling of GPS
- Support for section by section Qm's



Automated Data Screening Tool

Automated Data Screening For RDI ADCP Data

Water Track Error Velocity Filter

Percent Bad Data: 2.32
Number of Bad Bins: 400
Filter Criteria Maximum: 0.0375
Filter Criteria Minimum: -0.0375

Filter Parameters: Filter Multiplier: 4

Show ☒ Apply Filter Defaults Apply

Boat Velocity Filter

Percent Bad Data: 0.06
No. of Bad Ensembles: 7

Filter Parameters: Loess Smooth Width: 10
Filter Halfwidth: 10
Filter Multiplier: 9
Cycles: 3

Show ☒ Apply Filter Defaults Apply

Beam Depth Filter

No. Bad Depths

Beam 1: 4
Beam 2: 6
Beam 3: 1
Beam 4: 13

Filter Parameters: Loess Smooth Width: 20
Filter Halfwidth: 10
Filter Multiplier: 15
Cycles: 3

Show ☒ Apply Filter Defaults Apply

Edge Assessment

	Distance Traveled (m)	Bad Ensembles	Bad Nav Data
Start Edge:	1.49	11	0
End Edge:	23.93	49	0

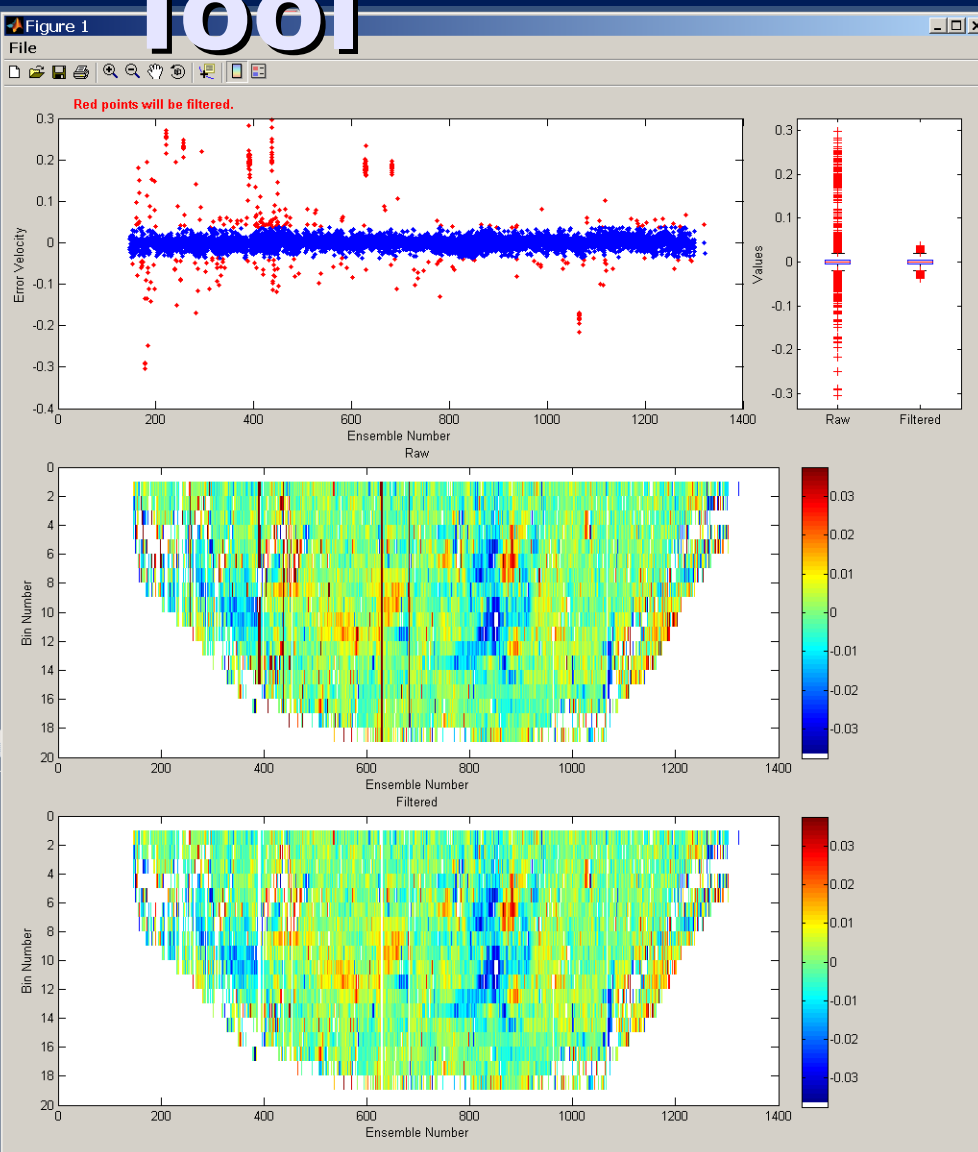
Summary

Measured Discharge (m³/s)

Raw Data: 2.8574
Filtered Data: 2.757

Show Final

Load Raw Data Close

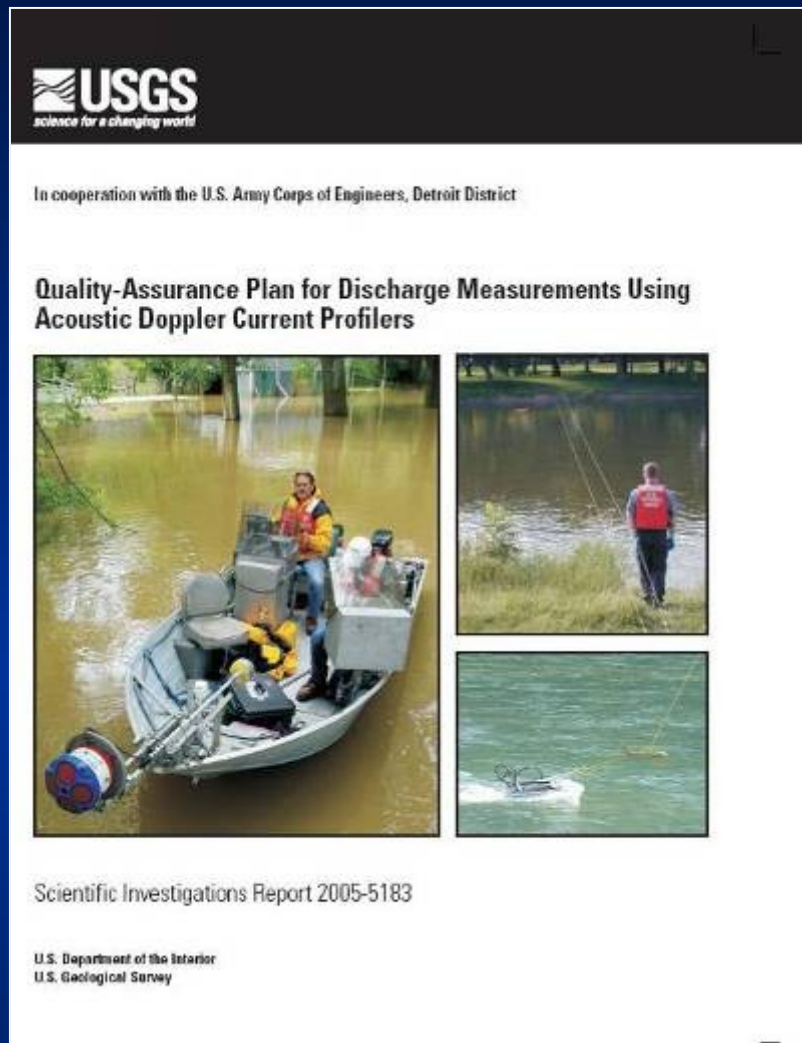


Quality Assurance

QA of ADCP Measurements

New information:

- Criteria for moving bed tests
- Temperature measurement
- Detailed procedures for Qm's



<http://pubs.usgs.gov/sir/2005/5183/>

Quality Assurance is Important!



OSW Technical Training

- ✓ Streamflow Measurements using ADCPs
- ✓ Advanced ADCP Applications
- ✓ Index Velocity Measurements and Ratings

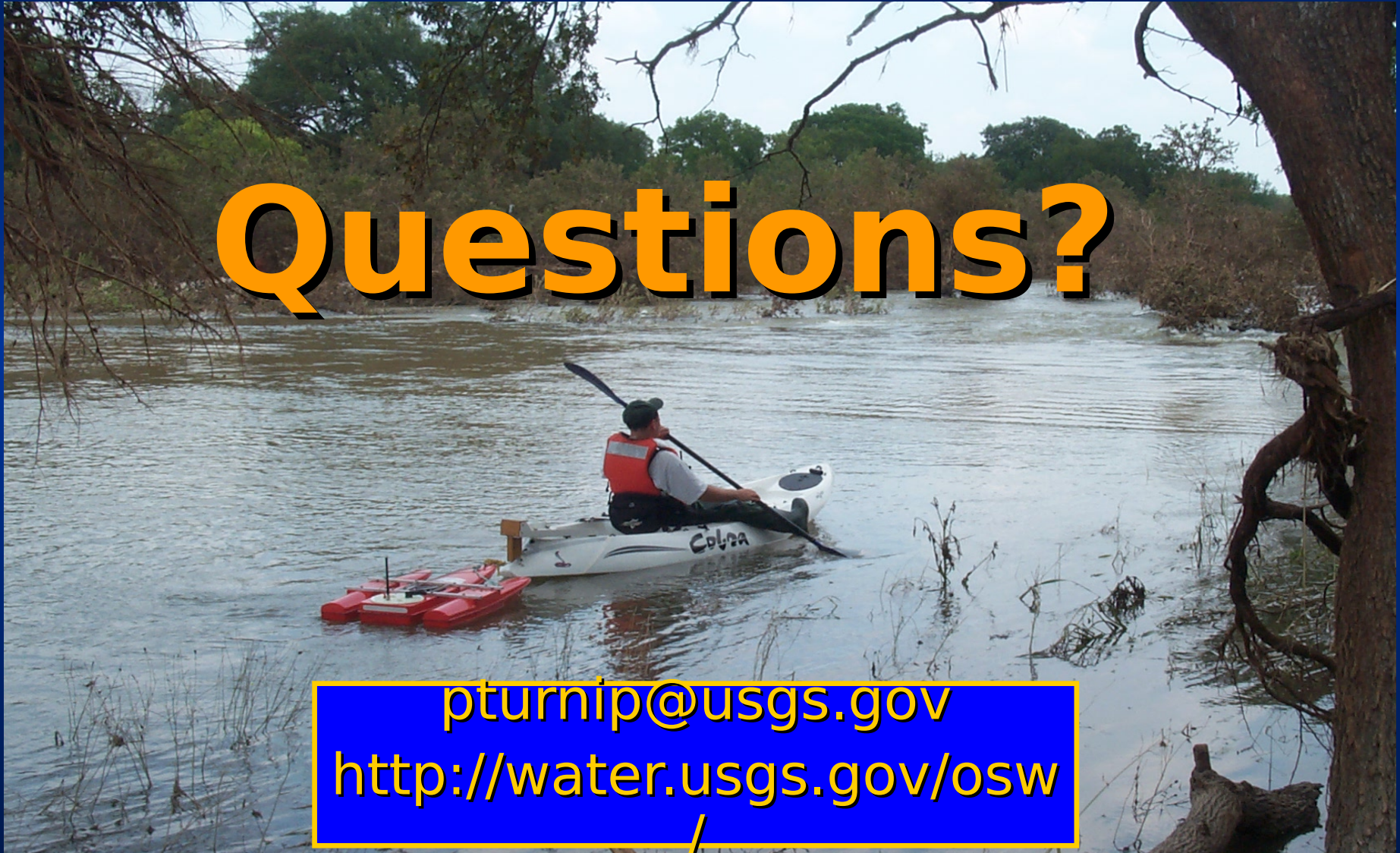
<http://il.water.usgs.gov/adcp/training/>

OSW Technical Memos

- 2000.03 Mandates use of WinRiver
- 2002.01 Configuration of RDI ADCP's
- 2002.02 Policy on ADCP Qm's
- 2002.03 Release of WinRiver 10.03
- 2003.01 Discharges computed using SonTek RiverSurveyor
- 2003.04 Release of WinRiver 10.05
- 2005.04 Release of WinRiver 10.06
- 2005.05 Guidance on use of RDI StreamPro
- 2005.08 Archiving ADCP Discharge Measurement Data
- 2006.02 Quality Assurance Plan for ADCP Qm's
- 2006.xx Moving Bed Test Procedures and Corrections
- 2006.xx Calibration of ADCP's used for Discharge Meas.



Questions?



pturnip@usgs.gov
<http://water.usgs.gov/osw/>